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NEBC MEETING NEWS

September 2004. Garrett Crow began with a slide show to preview the Saturday morning salt marsh field trip, followed by photos meant to interest the crowd in his July 2005 trip to the Amazon in connection with the New York Botanical Garden. He then introduced the evening speaker, Dr. Christopher Neefus from the University of New Hampshire, who spoke about "Living on the edge: Acclimation and adaptation of an intertidal seaweed."

Chris began his talk with a photo of Louis H. Sullivan, who designed office buildings during the late 19^{th} and early 20^{th} centuries. Louis, who often added beautiful botanical ornamentation to the facades of his buildings, was considered the father of the modern skyscraper, and was mentor to the famous architect Frank Lloyd Wright. More importantly, as Chris pointed out, he is credited with coming up with the concept of "form follows function," which Chris noted was an apt description of the evolution of intertidal seaweeds.

In the 1980s, Littler and Littler proposed a model of functional form for seaweeds, hypothesizing that physiological functions could be predicted via the seaweeds' morphological forms. Based on this model, there are six groups of seaweeds: Sheet, Filamentous, Coarsely Branched, Thick Leathery, Jointed Calcareous, and Crustose. In the shallow subtidal zone, the Thick Leathery group is well represented—the species found there tend to be tough, rubbery, and thick. These seaweeds have adapted to deal with the mechanical stress caused by wave action, and can tolerate changes in temperature, reducing enzymatic reactions when it is too hot or cold.

In the intertidal zone, seaweeds are submerged in ocean waters for only part of each tidal cycle, and as a result have had to evolve to tolerate an extreme range of temperatures, from −20°C to 40°C. When exposed to the air, they may also have to deal with high light levels and strong ultraviolet radiation. Mechanical stress can be as high here as in the subtidal zone, but decreases with increasing elevation. Competition from other seaweeds and herbivory also decrease as elevation increases. Common species found in the intertidal zone include *Ascophyllum nodosum* and *Fucus vesiculosus*, both from the Thick Leathery group.

In the highest part of the intertidal zone, the environment is often too extreme for the adaptations described above. One species found there is *Porphyra linearis*, a winter annual. This seaweed is an alga from the Sheet group that grows in thin layers on the tops of rocks. Having a life cycle that is restricted to winter and spring allows *P. linearis* to avoid the highest temperatures of the season. When exposed to air at low temperatures, this species freezes to the rocks, but is able to recover. Perhaps even more amazing, *P. umbilicalis* and *P. rediviva* respond to extreme heat by drying out completely, and can resume growth when they are rehydrated. Chris noted that there have been some amazing observations of *Porphyra* growth following the rehydration of dried herbarium specimens!

Since these species live so high up in the intertidal zone, they may be submerged for less than one hour each day, meaning they only have a short amount of time to acquire nutrients. In response, some *Porphyra* species have adapted to have the greatest rate of nutrient uptake within the first hour of exposure to a nutrient source. These nutrients can be stored within the seaweeds as phycobilin-protein pigments that also serve as accessory photosynthetic pigments.

To deal with interspecies competition, some *Porphyra* species have adapted to grow epiphytically on organisms such as barnacles, or even on other seaweeds including *Fucus* species. The moist tissue of the *Fucus* helps hydrate the *Porphyra*, extending the time the plant can photosynthesize. Chris went on to describe other adaptations of seaweed morphology to the harsh environment of the intertidal zone. Species with linear and lanceolate forms have low drag, allowing them to handle high levels of mechanical stress. These species may be "wave-pruned," but are fast growing and recover quickly by virtue of their form—they tend to be composed mainly of undifferentiated tissue, meaning there is little impact to the plant if part of it is torn away. Chris ended the talk by noting what may be the most important function of *Porphyra*—its form made it ideal to use as a wrapper for sushi.

—Jennifer Forman Orth, Recording Secretary.

September Field Trips. On Friday afternoon, September 10, Drs. Chris Neefus and Art Mathieson of the University of New Hampshire (UNH) led a party of approximately ten Club members and several UNH students to explore the seaweed flora of the rocky intertidal zone of Wallis Sands in Rye, New Hampshire, and the salt marsh of Brave Boat Harbor in Kittery, Maine. The rocky intertidal zone of Wallis Sands is a very exposed and disturbed environment, with high wave action and sand scour. The group scrambled down to the shoreline to observe the thick layer of wrack that had washed ashore. Several species were identified, with some noteworthy field characteristics. *Laminaria saccharina* (sugar kelp) is large and ribbon-like, with a very thick and strong holdfast. Somewhat smaller, *Laminaria digitata* (kelp) has "digits" along the margin. Although not a true kelp, *Agarum* sp. (shotgun kelp) could be identified by the numerous holes in the thallus. *Phycodrys rubens* (sea oak) is one cell thick except along the midrib. Green, threadlike, tangled balls of *Chaetomorpha* sp. were scattered about; *Desmarestia* sp. exudes sulfuric acid, and has minute spikelets on the margin. *Ulva* sp. (sea lettuce) could be discerned by its flat, bright green thallus.

A few low intertidal species were observed, including *Fucus spiralis*, *Chondrus crispus* (Irish moss), *Corallina*, and *Ascophyllum nodosum* (rockweed), which covered much of the rock surfaces of the intertidal zone. In the high intertidal *Porphyra umbilicalis* (nori) grew attached to rocks. This economically important seaweed is used in making sushi wraps. *Porphyra* was observed with variable pigmentation, from purple to green. The light-harvesting pigment phycoerythrin gives the thallus its purple coloration. The level of pigment depends on the light level. Plants growing in shaded areas are dark purple, while those exposed to full sunlight appear greenish. Pigmentation is also controlled by the amount of nutrient availability; a decrease in pigmentation may be associated with low nutrients.

For the second part of the field trip, Art Mathieson first described the habitat, morphology, and phenotypic variation of two seaweed species, *Ascophyllum nodosum* and *Fucus vesiculosus*. The group then journeyed through deciduous forests down to Brave Boat Harbor to search among *Spartina patens* for the seaweed. The Brave Boat Harbor salt marsh has a well-drained, sandy substrate and is highly susceptible to erosion. Art taught the group how to distinguish between ecads and germlings. The former is a phenotypic variant of a species and is caused by extensive proliferation and degeneration of detached fragments. Germlings could be discerned by the presence of a distinct, discoid holdfast. Several phenotypic variants were found, including *Ascophyllum nodosum* ecad *scorpioides*, *Fucus vesiculosus* ecad *volubilis*, and *Fucus cottonii*.

On Saturday morning, September 11, Dr. Garrett Crow of UNH, accompanied by his phytogeography class, led several Club members to explore the vascular flora of the salt marshes and sand dunes along the New Hampshire coastline. The first stop was to a salt marsh in Rye, just south of Odiorne State Park. Here, the group trekked through pure stands of *Spartina patens*, *Distichlis spicata*, and *Juncus gerardii*. Other species encountered in the salt marsh included *Atriplex subspicata*, dense red patches of *Salicornia europaea*, *Spartina alterniflora*, *Solidago sempervirens*, *Potentilla anserina*, *Triglochin maritima*, *Limonium carolinianum*, *Suaeda maritima*, *Plantago maritima*, and *Scirpus* *robustus*. In some of the pools, *Ruppia maritima* was found. Garrett discussed the geographic distribution of several species, the role of environmental factors in shaping this type of plant community, and adaptations of species to such conditions.

The group then met at the Seabrook sand dunes. This area represents the largest coastal sand dune remnant in the state of New Hampshire. Prior to protection of this community, the sand dunes suffered a substantial amount of disturbance from ATV (all-terrain vehicle) usage. Plants that colonize the dunes are adapted to strong prevailing winds, storm activity, shifting sands, salt spray, and high solar radiation. *Ammophila breviligulata* and *Lathyrus japonicus* are early colonizers of the foredune. Several species were observed among the dunes, including *Polygonella articulata*, *Lechea maritima*, *Cakile edentula*, *Artemisia stelleriana*, *A. caudata*, *Hypericum gentianoides*, and *Myrica pensylvanica*. *Prunus maritima* grew intermixed with *Toxicodendron radicans*, making the collection of its sweet and succulent fruit a risky endeavor. Because the sand dunes are a rare community in New Hampshire, this area is the location of several state-listed taxa, including *Aristida tuberculosa*, *Cyperus grayi*, and *Hudsonia tomentosa*, all of which the group observed. Sunken forests, hollows among the dunes where the establishment of shrubs is followed by tree species, were scattered among the dunes. A few members of the group followed Garrett into one of them. The sunken forest was cooler, being densely shaded by a canopy of *Acer rubrum*, *Populus tremuloides*, and *Pinus rigida*. Shrub species included *Ilex verticillata*, *Amelanchier stolonifera*, *Vaccinium* sp., and *Viburnum* sp. The forest floor was colonized by species such as *Parthenocissus quinquefolia*, *Aralia nudicaulis*, *Trientalis borealis*, *Maianthemum canadense*, and *Carex pensylvanica*.

—MARE NAZAIRE, Recording Secretary *pro tempore*.

October 2004. The New England Botanical Club celebrated its 1000th meeting since its original organization at the Massachusetts Audubon Society's Broadmoor Wildlife Sanctuary in Natick. Members and guests enjoyed hors d'oeuvres and displays of botanical art by club members Erika Sonder and Anita Sebastian, while a slide show of images and documents from the NEBC archives was displayed on a large screen. After a catered buffet, President Art Gilman welcomed everyone and spoke briefly about the many great "Away" meetings the club has had in and around New England over the past few years. He noted that the club currently has more than 400 members; they and 350 institutions subscribe to *Rhodora*.

Past President Lisa Standley introduced the evening's speaker, Dr. David Barrington from the University of Vermont. The club has had the honor of hearing Dave speak on several occasions over the years. For the thousandth meeting of a club that spends most of its time asking why plants grow where they do, his talk was appropriately titled "The Big Thaw: New England Flora in the Holocene."

Dave began his talk by noting that the mountaintops of New England had captured the fascination of many of the first NEBC members. Ausable Chasm in New York serves as one striking lesson in the effects of time and change on flora and fauna. A deep and narrow divide almost a mile long, it was originally thought to have been formed in the Oligocene era, but actually developed during the last 10,000 years.

In 1846, a beluga whale was unearthed during the construction of a railroad in Vermont. The presence of such a creature, referred to as the "Charlotte Whale" after the town near where it was discovered, supports the idea that there was once an arm of the ocean in the Champlain Valley. While studying flora from the Pleistocene glaciation, E. C. Pielou concluded that at maximum glaciation (18,000 years ago), ice covered much of the terrain. However, during this ice age a series of large sandy islands was exposed along the northeast coast. Lake Champlain was indeed at one time an arm of a giant sea whose land was compressed by the huge weight of ice.

Dave described the work of Norton Miller, who has studied the recovering New England flora of 12,000 to 13,000 years ago, specifically looking at when and where species were found. This work uses both pollen cores and macrofossils. The portions of a species' range where the highest genetic diversity is found are thought to be those where populations have been around the longest, especially those that survived through the ice age in what are termed "refugia." For example, when looking at *Fagus sylvatica* in Europe, scientists found that genetic diversity in this species is highest in the southernmost part of its range. This is hypothesized to be because subsets of the southern populations were able to "hide out" in refugia through the ice age. Another example of this pattern is *Asclepias exaltata*, an eastern North American milkweed species that is very common in the South. In the North, it is rare and has low genetic variation as well.

Saxifraga oppositifolia is found at Smugglers Notch in Vermont on wet cliffs; the southern limit of its distribution is currently in New England. A group headed by Dr. Abbott did a genetic study of this species, which was found to have spent the height of the Pleistocene era on exposed land in Siberia, where the highest genetic diversity is now found. The species then repopulated the Arctic through North America and through Eurasia. *Dryas integrifolia* is another Arctic species for which a set of refugia can be hypothesized from genetic data. There are many records of the pollen of this species as well as fossils in refugia, with two centers of diversity being the high Arctic and Beringia.

Dave then described the thesis research of Pete Walker, a University of Vermont graduate who worked with Cathy Paris. Pete studied *Ammophila breviligulata* (beach grass), which is widely distributed along the Atlantic coast and Great Lakes regions. However, plants found along Lake Champlain have been labeled as *A. champlainensis*. There has been some question as to whether this was a "true" species, though the Lake Champlain plants flower in a different month. Pete determined that the Great Lakes populations were actually morphologically intermediate between the North Atlantic and Lake Champlain populations. It is likely that the Lake Champlain plants arrived with the ancient Champlain Sea and diverged from other populations since the salt waters receded 10,000 years ago. The North Atlantic populations have the highest genetic diversity, likely because there was plenty of exposed sand on the coast during the Pleistocene, providing a refugium. *Lathyrus japonicus*, often a companion of beach grass, grows on both the Atlantic and Pacific coasts of North America. An isozyme study showed that Pacific alleles were most common in the north and dwindled in the south, while Atlantic alleles were found only in the Atlantic populations, suggesting that there are actually two endemic centers for this species.

Dave spent the last part of his talk discussing several other interesting case studies of plant species that survived the Pleistocene era in refugia, including *Adiantum pedatum*. He mentioned *Hudsonia* as a candidate for future study of glacial refugia and Holocene migration. He then took several enthusiastic questions from the audience. The Club finished the 1000th meeting celebration with an excellent dessert table and a sparkling cider toast.

—JENNIFER FORMAN ORTH, Recording Secretary.